Lake Erie Fisheries Assessment Unit
Report 1987-1

Preliminary Estimates of Incidental Smallmouth Bass Mortality in Gill Nets in Long Point Bay (1983-84)

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EXECUTIVE SUMMARY

1. Incidental kills of smallmouth bass in commercial gill nets were investigated for the late July-August period in Long Point Bay using the following two methods:

   (a) examination of incidental smallmouth bass catches in 1983 and 1984 during simulated commercial fishing along the Fishing Reserve Boundary, and

   (b) on-board surveillance of incidental bass mortality in 11 actual commercial fishing catches observed in 1984.

2. Total kills of smallmouth bass in commercial gill nets were estimated for the late July-August period of 1983 by expanding the incidental catches of bass per unit of effort (CUE's) from actual and simulated commercial fishing, to the total effort reported by commercial fishermen within six grids encompassing the Fishing Reserve Boundary (see Figure 3).

3. Incidental catches of bass per unit of effort, and estimated kills in late July through August (1983) were higher using catches from simulated commercial fishing data than from catches observed on-board the commercial vessels. The following three independent estimates of smallmouth bass kills in 1983 were made (assuming 100% mortality):

   (a) 9,386 ± 2,826 bass using our 1983 simulated commercial fishing catches,

   (b) 9,954 ± 4,259 bass using our 1984 simulated commercial fishing catches, and

   (c) 6,238 ± 5,097 bass using data from the 11 actual commercial fish catches examined during the on-board survey.

4. Confidence limits on the estimate from the on-board survey were unacceptably wide (±82% of the estimate) suggesting that the sample size in this survey was too small (N = 11); thus, the apparent discrepancy between CUE's in simulated fishing and those from the on-board survey was suspect.

5. Despite the apparent wide discrepancy, smallmouth bass CUE's derived from simulated fishing in 1984 (13 bass/km) and from the on-board survey in 1984 (6 bass/km) were not significantly different, statistically. Therefore, all data from both survey types were combined to generate a single pooled estimate of 7,053 ± 1,451 bass killed. This estimate is considered the best available approximation of the true kill in late July and August.

6. Presently, our confidence in the estimated kills is low, and the apparent discrepancy in mortality estimates between those derived from the on-board survey and those derived from simulated fishing bears closer examination. It is conceivable that an unknown proportion of the commercial effort reported from the grids encompassing the Fishing Reserve Boundary occurred in waters well removed from the line. Thus expanding our CUE's from simulated fishing (which were derived by fishing on the line) to total effort within these grids may have biased the estimates (probably upwards). Furthermore, some fishermen may, from past experience, purposely avoid areas where incidental catches of bass tend to be high (our simulated fishing locations were chosen at random with no attempt to avoid or concentrate on such areas).

7. Preliminary studies suggest that mortality of smallmouth bass in gill nets may be substantially reduced if commercial fishermen would routinely remove live entangled bass at the puller and immediately return them to the water.

8. We emphasize that the estimates of incidental bass mortality provided herein are preliminary, and relate only to the late July - August period. Information concerning incidental kills in other seasons is lacking; therefore, it is premature to speculate on the total, annual kill.

9. The information presented in this document is inadequate to evaluate the impact of incidental bass kills, and no management action should be taken on this basis alone. If this issue continues to be of concern the following additional work is recommended:

    (a) further and more intense on-board observations of actual commercial fish catches,

    (b) examinations of incidental catches through all seasons in which commercial fishermen operate,

    (c) surveys to determine the distribution of commercial effort within the grid locations of interest,

    (d) examinations of trends in incidental catches as nets are set further from the Fishing Reserve Boundary, and

    (e) attempts to estimate the size of the smallmouth bass population, particularly in the Inner Bay,

10. Evaluation of the incidental kill and its effect on the smallmouth bass population should not be done without considering the substantial harvest of bass by anglers.

1.0 INTRODUCTION

Commercial and sport fishing thrive on Long Point Bay, and are of considerable importance to the local economy. Commercial fishing on Long Point Bay consists of an outer bay fishing fleet of modern trawlers and gillnetters based in Port Dover, and a relatively small commercial hoop and seine net fishery in the Inner Bay. The quality of sport fishing in Long Point Bay is renowned, and provides the best fishing for smallmouth bass, Micropterus dolomieui, in Ontario (Sztramko 1985). Up to 7,000 anglers may be found on the Inner Bay on opening day of bass fishing (Whillans 1981) and anglers harvest an average of some 50,000 bass annually. Both user-groups depend heavily on yellow perch, Perca flavescens, although the principal summer target species of anglers is smallmouth bass, whereas gillnetters seek yellow perch and trawlers rainbow smelt, Osmerus mordax.

Several regulations serve to minimize conflicts between sport and commercial fishermen on Long Point Bay by separating them in time and space. These regulations are partially successful in terms of the above objective. Despite regulations prohibiting the harvest of smallmouth bass by commercial fishermen, the incidental catch of this species in yellow perch gill nets is perceived by some anglers to be excessive. Occassionally anglers attribute poor smallmouth bass fishing to excessive incidental kills by commercial gill net, and it is thought that this may become a strong issue as time progresses. Whether the problem is perceived or real is a subject of much debate, without the advantage of reliable data.

In 1983 Simcoe District (Ontario Ministry of Natural Resources) established a spring no-fishing zone in the Inner Bay to reduce or eliminate the incidental catch by anglers of spawning and nest-guarding smallmouth bass on their spawning grounds, prior to opening day of bass season (Appendix Figure I). It was during initial attempts by OMNR to implement this regulation that complaints from anglers regarding the incidental catch of bass in commercial gill net became more prominent. Angling groups complained that implementation of this no-fishing zone (which became law in 1984) was misdirected, and that elimination of the incidental bass catch in commercial gill net would be a more effective means of protecting the population.

This report describes the results of some preliminary work carried out in 1983 and 1984. These studies examined the incidental catch of smallmouth bass in commercial gill net by on-board observations of commercial fishing catches, and by simulating commercial fishing at a time and in areas where incidental catches are thought to be highest.

2.0 STUDY AREA

Long Point Bay (42°37' N, 80°10' W) is situated on the north shore of the eastern basin of Lake Erie (Figure 1). The water quality of outer Long Point Bay has been classified as oligomesotrophic and is described as the best in nearshore Lake Erie (Heathcote 1981). Leach (1981) classified the shallow (mean depth = 1.0 m) Inner Bay as eutrophic (Figure 1). Numerous fish species use the physically protected waters of the Inner Bay and north shore of Long Point as spawning and nursery grounds, and such species as rock bass, smallmouth bass and yellow perch move to these areas from outer Long

Point Bay to spawn (MacLean and Teleki 1977, Hamley 1981, Sztramko 1985, Pynenburg and Witzel 1984, MacGregor and Witzel 1986).

The great majority of angling occurs in and near the Inner Bay. In 1980, an estimated 212,623 fish were harvested by the summer boat fishery (46.5% yellow perch, 24,8% rock bass and 22.2% smallmouth bass; Owen 1980). Between 1978 and 1983 this fishery has produced an estimated mean annual harvest of 53,800 smallmouth bass (26,600 kg) for an annual yield of 4.9 kg of bass per hectare (Sztramko 1985). Some 40 commercial fishing tugs operate on outer Long Point Bay. Approximately 9.1 million kg of fish were harvested by this fishery in 1982, and trawlers in Long Point Bay take about 75% of the rainbow smelt harvested from Lake Erie. In 1981, some 10,683 metric tonnes (mt) of rainbow smelt and 199 mt of yellow perch were harvested from Long Point Bay and adjacent waters (Statistical District 4; Figure 3) amounting to a landed value of $3,118,749.

Pertinent management regulations are described in detail by MacGregor (1983) and references therein. Of most importance to this issue are the regulations designed to separate anglers in time and/or space from commercial fishermen on Long Point Bay. Intended principally to minimize the incidental catch of sport fish and conflicts with recreational users of Inner Bay - Long Point waters, gill nets and trawls are restricted to waters of Long Point Bay outside of the line illustrated on Figure 1. Waters west of this line are referred to as the restricted zone and the line is termed the Fishing Reserve Boundary. For the same general reasons, hoop and seine nets are prohibited from the restricted zone between May 13 and August 31 of each year. The harvest of game fish by commercial gear is prohibited,

and any live game fish taken by this gear must be returned to the water from which they were taken; dead game fish can be retained (not sold) but must be turned over to a fisheries officer.

3.0 METHODS

3.1 GENERAL METHODOLOGY

Observations by provincial conservation officers and reports by anglers suggested that the incidental catches of smallmouth bass in commercial gill nets were highest in Long Point Bay during the period between the last week in July and the end of August (Ellah and Reid, personal communication, 1983). These catches were observed to occur along the Fishing Reserve Boundary, and along the north side of Long Point from Bluff Bar to Gravelly Bay. This has been the most contentious area; thus, the sampling locations for these preliminary studies were restricted to sites along the Fishing Reserve Boundary (beginning at a point adjacent to Port Ryerse), and along an artificial extension of this line from Bluff Bar to Gravelly Bay (Figure 1).

The major procedure used in this project was to simulate commercial fishing, specifically in terms of fishing gear, target species and technique. Essentially we achieved this by adopting techniques used by Long Point Bay gillnet fishermen to maximize harvests of legal size yellow perch (the most common target species of gillnet fishermen in these waters). Throughout this study we used two straps (Table 1) of commercial gill net that had actually been used by commercial fishermen in Long Point Bay.

In 1984 a series of observations made on-board the commercial fishing fleet supplemented our simulated commercial fishing.

3.2 1983 SIMULATED COMMERCIAL FISHING

Potential sampling sites in 1983 were established by plotting points at equal intervals along the Fishing Reserve Boundary (and extension) on a nautical chart (1:50,000) of Long Point Bay. Twenty of these sites were selected at random by computer generation of the site numbers and sampling order (Figure 1). The lat-long coordinates of each sampling site were taken from the nautical chart and coordinates were located by a LORAN-C navigational aid (INTERNAV LC360). A final set of lat-long coordinates were taken by LORAN-C after each strap had been set. At most locations each strap was set perpendicular to shore. Four sites were sampled each week over a 5 week period beginning July 25, 1983 and ending August 24, 1983. The sampling schedule is summarized in Table 2.

During the first sampling week (locations 12, 42, 25 and 22) one strap contained 21 nets totalling 1,413 m in length; the other containing 22 nets totalling 1,270 m. Subsequently, nets were removed so that each strap contained 20 nets for the duration of the sampling schedule; thereafter, STRAP 1 measured 1,350 m in length and STRAP 2 1,174 m. Each strap contained a variety of mesh sizes (frequently within one net where it had been mended with other mesh sizes) ranging from 54-mm (2-1/8 in) to 60-mm (2-3/8 in) stretched mesh; nets within a strap measured 20 meshes deep.

All fish harvested at each sampling site were sorted according to species, counted and weighed in bulk to the nearest 0.1 kg (Chattillon

Hanging Autopsy Scale, Model 815H) on board; these data were collected and summarized per net within the strap. In addition, we recorded the mesh size from which each smallmouth bass was captured. All smallmouth bass were taken to the Port Dover laboratory where fork and total lengths (nearest mm), weights (nearest 1.0 g) and sex were determined. Scale samples were taken from the right side of each bass near the tip of the pectoral fin when depressed, and sent to the Lake Erie Fisheries Assessment Unit (Wheatley, Ontario) for aging, using January 1 as the birth date.

3.3 1984 SURVEYS

The 1984 study consisted of two surveys. The first survey essentially repeated the simulated commercial fishing exercises carried out in 1983, while the second survey consisted of a series of on-board observations by OMNR staff accompanying commercial gillnet vessels during their regular fishing day. In addition, we made a cursory attempt to examine the potential survival of smallmouth bass that had been entangled in gill net during simulated commercial fishing.

A. *Simulated Commercial Fishing*

Simulated commercial fishing in the 1984 survey was similar to that carried out in 1983; thirty-two of a potential 65 sites (Figure 2) were selected randomly by computer generation of site numbers and sampling order. In 1984 potential sampling sites were established by plotting points at 0.5 km intervals along the Fishing Reserve Boundary (and extension) on a nautical chart (1:50,000) of Long Point Bay. Location of these sites and final recording of net positions were

again established by LORAN-C navigational aid. In 1984 nets were set parallel to shore along the Fishing Reserve Boundary as it was found that most commercial fishermen set in this manner in this area of the bay; however, we continued to set the nets perpendicular to shore along the artificial extension of this line. The same two gillnet straps were used in 1984 as those deployed in August 1983 (see Table 1), but because a mesh size restriction was introduced in 1984, we removed all nets less than 2-1/4 in and replaced them with this mesh size. Six locations were sampled per week for the first 4 weeks (July 24 - August 16, 1984); thereafter, 4 locations were sampled per week until the end of August. The 1984 sampling schedule is summarized in Table 3.

The catches from these sites were tallied and processed in the laboratory in a manner identical to that in 1983.

B. *On-board Observations*

Between July 24, 1984 and August 31, 1984, OMNR staff accompanied commercial gillnet fishermen during 11 separate fishing occasions. An attempt was made to accompany only fishermen who were fishing near the Fishing Reserve Boundary, but this was not always possible. In many instances fishermen had set several different straps at different locations. The sampling schedule for this survey is outlined in Table 4. The grid location, total catches of yellow perch and smallmouth bass, and the associated gillnet effort were recorded on each occasion; all smallmouth bass were returned to the LEFAU laboratory in Port Dover for processing. In addition, we attempted to obtain more precise location information by recording the LORAN-C co-

ordinates from the fisherman's instruments for each strap he pulled; the positions of these straps for which LORAN coordinates were available are shown on Figure 3. Catches for each fisherman were summarized as the total catch for the day in association with the total length of net he had set on that day, regardless of the number of straps that were deployed.

C. *Estimated Survival From Entanglement*

In 1984 we investigated the possibility of smallmouth bass surviving accidental entanglement in smallmesh perch gill net. Some commercial fishermen contend that most smallmouth bass captured incidentally in gill net can be removed and returned to the lake alive and relatively unscathed, particularly if they are removed as the nets are brought on board. Between July 24 and September 28, 1984 we attempted to investigate this issue by the following two rather rudimentary methods:

(i) Smallmouth bass in each strap of gill net were removed at the puller as our nets were brought on board, and the number of live and dead (no visible movement) bass counted. This procedure was followed at all 1984 simulated commercial fishing locations until the week of August 27, when the procedure was followed only at the second of two locations sampled on each lift day. Thereafter, the numbers of live and dead bass at the first location of each lift day were not assessed until the entire strap of net had been brought on board and bass encountered as the nets were overhauled and picked.

(ii) Live smallmouth bass (usually no more than the first 10) removed from the nets were placed in a live tank on board our vessel. Oxygen and temperature levels in the tank were controlled by constant supply of fresh water, addition of compressed air to the tanks and addition of ice if temperatures rose. The number of live and dead bass were counted in the tank at the end of the holding period (which varied according to on-lake time but averaged about 100 minutes).

3.4 DATA ANALYSIS

Data summaries were performed on an IBM 370 computer at Queen's Park, Toronto using SAS statistical packages (Anonymous 1982). Catches per unit of effort (CUE) were calculated as the number or weight (kg) of a given species per kilometer of net, so that our data could be related to summaries of total catches and total effort (km of gill net) expended by commercial fishermen within the study area.

Commercial fishermen are required by law to submit reports of their fish catches, and the associated amount of fishing effort expended, on a daily basis. Fishing effort is reported by fishermen as the total number of yards of gill net they set on a given day; we convert this to metric equivalents and refer to fishing effort as the total number of kilometers (km) of gill net set. Fishing effort is also expressed as the total number of fishing occasions (ie. daily fishing trips) in a given period of time and catches per unit of effort in these terms would be the number of bass caught per fishing occasion. Included in the reports by commercial fishermen are the locations where their daily fishing effort was expended; for convenience OMNR has partitioned Lake Erie into a series of grids and the fisherman reports his daily fishing location(s) by indicating the grid number(s) in which he fished (see Figure 3).

We used this information to estimate the total number of smallmouth bass killed by expanding the catches of bass per unit of effort (catch/km or catch/fishing occasion) calculated in our surveys, to the total effort reported by all fishermen over the same time frame as our survey period (July 24-August 31). In this expansion we only used

effort reported from locations encompassing the Fishing Reserve Boundary (ie. grids 94, 110, 111, 137, 138, 139; Figure 3), and it was assumed that all effort expended in these grids occurred near the line. In total, the effort expended within these grids was derived from 203 individual fishing occasions reported between July 24 and August 31, 1983. Because grid summaries of commercial gillnet effort expended in 1984 were not available, only the effort reported from 1983 in these grids was used in the expansions, regardless of whether expansions were from catches in the 1983 or 1984 surveys. Thus it was assumed that the effort expended by commercial fishermen within these grids in 1984, was similar to that expended in 1983.

The concept of expansions to estimate kills is as follows: if an average of 10 bass/km of gill net was calculated in our surveys and the total amount gill net effort reported by commercial fishermen was 100 km, then the estimated kill would be (10 bass/km) x (100 km) = 1,000 bass. There are a number of assumptions in making these expansions which are discussed throughout this document. Through a series of statistical calculations 95% confidence limits can be placed on these estimates which, in simplistic terms, tell us that we are 95% confident that the computed interval contains the true estimate (sample calculations are in Appendix Table I).

For this exercise we assumed that mortality of entangled bass was 100% and calculated three independent estimates of the number of bass killed between July 24 and August 31 as follows:

(a) by expanding the number of bass caught per unit of effort (km) in our 1983 simulated fishing, to the total length of gill net (km) reported to have been

set by commercial fishermen for the July-August period in 1983 (758.586 km),

(b) by expanding the number of bass caught per unit of effort in our 1984 simulated fishing, again to the total commercial effort for the same period in 1983 (758.586 km), and

(c) by expanding the mean number of bass caught per commercial fishing occasion observed during the 1984 on-board survey, to the total number of fishing occasions reported for the July-August period in 1983 (N = 203).

In reality, these are estimates of the number of bass entangled and, as noted later, mortality may depend on how the individual fishermen treat the catch.

Analyses of variance were performed to test the differences in yellow perch and smallmouth bass CUE's derived from simulated commercial fishing vs those derived from actual commercial fish catches during the on-board survey. These analyses were performed on $\log_e$ catches per unit of gillnet effort (1 was added to all catches by number or 0.1 to all catches by weight to avoid taking logarithms of 0). The GLM procedure in SAS (Anonymous 1982) was used for all ANOVAS.

4.0 RESULTS

4.1 1983 SIMULATED COMMERCIAL FISHING

In the 20 nights of simulated commercial fishing, a total of 25,558 m of gill net were examined. The total catch consisted of 37,257 fish (3,387 kg) representing 15 species. Some 3,722 yellow perch and 317 smallmouth were captured during this period (Table 2). Gizzard shad (Dorosoma cepedianum) were by far the most abundant species in the catch, and represented 74.6% of the total harvest by number or weight.

Yellow perch (the target species) were the next most abundant and represented some 10% of the total catch by number or weight. Only 2 species of game fish (as defined in OFR 1982) were harvested (317 smallmouth bass and 2 rainbow trout). However, other non-gamefish species were harvested that are sought highly by anglers, including 4 coho salmon and 11 walleye. The total harvest of game fish represented the total catch by less than 1% in number and less that 2% by weight. Smallmouth bass represented 8.4% by number (or 14% by weight) of the total catch of the target species (yellow perch). Over 98% of the smallmouth bass harvested were age 2 or 3 (44% age 2, 54.5% age 3).

Gizzard shad were caught most frequently per unit of effort (average CUE = 1,087 fish per km of net), and non-target species (1,312 fish/km) were taken much more frequently per unit effort than the target species (146 fish/km) (Table 5). Catches of smallmouth bass per unit of effort averaged 12 bass/km (or 2 kg/km) over the entire survey area, 12.3 bass/km along the actual Fishing Reserve Boundary, and 12.7 bass/km along the artificial extension. Some 68% of the smallmouth bass were captured in the 57-mm stretched mesh, although this mesh size accounted for 56% of the total length of net set.

Catches and CUE's of all fish species varied considerably among locations (Table 5). Highest smallmouth bass CUE's occurred in the vicinity of Bluff Bar, although CUE's along the north shore between Turkey Point and Port Ryerse were also relatively high (Table 5, Figure 4). Descriptive statistics and interrelationships among all measured parameters are presented in MacGregor (1983) as correlation coefficient matrices of raw and $\log_e$ transformed data.

4.2 1984 SURVEYS

A. *Simulated Commercial Fishing*

In the 32 nights of simulated commercial fishing, a total of 42,384 m of gill net were examined. The total catch consisted of 11,124 fish (1,471 kg) representing 14 species. Some 5,204 yellow perch and 530 smallmouth bass were captured during this period (Table 3). Gizzard shad catches were considerably lower in 1984 than in 1983, representing only 3.8% of the total harvest by number and 16.1% by weight. Yellow perch were the most abundant species in the catch and represented 46.8% of the catch by number or 36.2% by weight. Again, only 2 species of game fish (as defined in OFR 1982) were harvested (530 smallmouth bass and 3 rainbow trout). However, other non-gamefish species were harvested that are sought by anglers, including 14 coho salmon and 22 walleye. The total harvest of these 4 species amounted to 569 fish (92.8 kg) and represented the total catch by 5.1% in number or 6.3% in weight. Smallmouth bass represented 10.2% by number (or 13.8% by weight) of the total catch of the target species (yellow perch).

Non-target species (145 fish/km) were captured slightly more frequently per unit of effort than were the target species, yellow perch (129 fish/km) (Table 6). Catches of smallmouth bass per unit of effort averaged 13 bass/km (or 2 kg/km) over the entire survey area, 12 bass/km along the actual Fishing Reserve Boundary and 22 bass/km along the artificial extension. Gizzard shad catches averaged only 10 fish/km in 1984 (compared to 1,087 fish/km in 1983).

Of the smallmouth bass sampled, 89.5% were age 2 or 3 (31.4% age 2, 58.1% and 3). Some 88% of the bass and 86% of the perch were taken in the 57-mm mesh, the remainder being captured in 60-mm mesh.

Again, catches and CUE's of all fish species varied considerably (Table 6). Highest smallmouth bass CUE's occurred near Bluff Bar and along the north shore, particularly in the Fisher's Glen - Turkey Point area (Figure 4).

B. *On-board Observations*

OMNR staff accompanied commercial perch fishermen on 11 separate fishing occasions and inspected the catches from a total of 52,981 m of gill net. Some 5,807 yellow perch (586.4 kg) were harvested by these fishermen and 338 smallmouth bass were captured incidentally by their nets (Table 4). These catches amounted to an average of 11.1 kg of yellow perch per kilometer of gill net (or 110 fish/km) and 6 smallmouth bass per kilometer of net (or 1 kg/km). The catches varied considerably among grid locations (Figure 5), but sample sizes were too small to enable examination across locations.

Some 96% of those smallmouth bass captured by commercial fishermen were age 2 or age 3 (42.6% age 2, 52.9% age 3).

C. *Comparisons Among Catches From Simulated Commercial Fishing and During the On-Board Survey*

Analyses of variance revealed that catches of yellow perch per unit of effort were not statistically significantly different between the 1983 and 1984 simulated commercial fishing ($F = 0.13$, $P = 0.7211$), nor were the smallmouth bass CUE's significantly different between years (F =

1.34, P = 0.2518). Analyses of variance comparing the yellow perch CUE derived from our 1984 simulated commercial fishing with that from the actual commercial catches during the on-board survey, detected no statistically significant difference (F = 0.03, P = 0.8662). Despite the apparent discrepancy between the smallmouth bass CUE derived from simulated commercial fishing in 1984 (13 fish/km) and that from the actual commercial fishing catches during the on-board survey (6 fish/km), it is important to note that the difference was not statistically significantly different (F = 2.56, P = 0.1174).

D. *Estimated Survival From Entanglement*

During 33 occasions when the numbers of live and dead smallmouth bass entangled in our nets were counted at the puller, an average of 70.2% of the bass were alive (Table 7). On the nine occasions when the numbers of live entangled bass were not counted until the entire strap was on board, overhauled and picked only 17.1% remained alive; whereas over the same days, an average of 74% of the bass were alive at the puller (Table 7).

Of a total of 265 live bass removed from our nets and placed in the holding tank aboard our vessel, an average of 88% of the bass were still alive at the end of the holding period.

It must be emphasized that these investigations were far from controlled, scientific experiments and thus the results must be interpreted with caution.

4.3 ESTIMATED SMALLMOUTH BASS KILLS

Expansions of smallmouth bass CUE's in our simulated commercial fishing to the total commercial gillnet effort reported by fishermen (758.586 km) in the grid locations between July 24 and August 31, resulted in estimated kills for this five week period of 9,386 ± 2,826 bass using our 1983 catches, or 9,954 ± 4,259 bass using our 1984 catches. Because observed catches of smallmouth bass in the 11 actual commercial fishing occasions observed during the on-board survey were considerably lower (and much more variable) than those in our 1983 or 1984 simulations, estimated kills were considerably lower (but confidence limits much wider) using these data. By this method, the estimated kill in late July and August was 6,238 ± 5,097 bass using the reported number of individual fishing occasions (N = 203) as the expansion factor.

As no statistically significant differences in smallmouth bass CUE's were detected between those derived from simulated commercial fishing and those from the on-board survey, all 1984 data (simulations and on-board survey) were pooled together to provide one pooled ratio estimate of the smallmouth bass kill. This was done by expanding the pooled CUE to the total reported gillnet effort in km (See Appendix I). In so doing, the pooled catch of smallmouth bass per unit of gillnet effort became 9.3 bass/km and yielded a pooled estimated kill of 7,053 ± 1,451 bass.

It is important to note that all these estimates may be biased upwards because they assume that all reported effort in the grids of interest was expended near the Fishing Reserve Boundary. In addition, these

estimates assume no bass are returned to the lake alive and thus mortality is 100%.

5.0 DISCUSSION

Our approach of simulating commercial fishing was advantageous in two respects. Firstly, it allowed us to collect very accurate information concerning the total effort expended and total numbers and weights of fish caught. Secondly, it allowed us to control the effort and direct it towards areas of most concern. As there was no way to control when or where commercial fishermen would fish, only in this way could we examine whether certain areas were more prone to producing high incidental catches of bass than others.

However, in this approach it is important that our simulated fishing be very comparable to that carried out by commercial fishermen; hence, in 1984 we also carried out a survey on-board commercial fishing vessels as one cross-check on the performance of our simulated fishing. Also available were complete daily and monthly summaries of all commercial catch and effort data associated with 1983 perch fishing in Long Point Bay, summarized by grid location. Thus, we were able to cross-check our simulated perch fishing in 1983 with that of the commercial industry in the same grid areas over the same time period.

Two years of simulated commercial perch fishing provided good comparison in catches of yellow perch (the target species) between our fishing and the catches of commercial fishermen. The average CUE for yellow perch derived in late July and August from simulated fishing was 14 kg/km in 1983, which is almost identical to the average

reported CUE (14.5 kg/km) by commercial fishermen who fished in the study area over the same period. No grid summaries of commercial fishing effort in 1984 were available; however, in 1984 simulated commercial fishing in late July and August produced an average perch catch of 12 kg/km (129 fish/km) which compares favorably to the average catch by fishermen during our on-board survey (11 kg/km, or 110 fish/km).

In 1983, gizzard shad were so abundant in our simulated commercial fishing catches that we were forced to terminate our survey one week early; similarly, unusually high gizzard shad catches in commercial gill net forced most fishermen in the area to reduce or cease fishing entirely during this period. Probably for this reason, commercial effort reported in late July-August, 1983 was lower than the average 1980-1982 effort reported in these grids (1983 = 758.6 km; 1980-1982 mean = 990.8 km). In 1984, gizzard shad catches were not a problem in our simulated commercial fishing nor for commercial fishermen. Thus, the evidence suggests that our gill netting simulated commercial fishing for yellow perch rather well. This was not surprising since we had adopted techniques used by commercial fishermen, used commercial gear and fished in areas where commercial fishermen tended to concentrate (most gillnetters west of Pt. Dover tend to set their nets extremely close to the Fishing Reserve Boundary - as did many of those during our on-board survey in 1984, Figure 3).

In light of the above evidence, the apparent discrepancy between the incidental catches of smallmouth bass in our simulated fishing and those in commercial nets during the on-board survey was unexpected.

While both survey types produced virtually identical size- and age-composition of smallmouth bass in the respective incidental catches, smallmouth bass CUE's in our simulated fishing were almost twice as high as those observed during our on-board sampling of commercial fishing. The variability in incidental bass catches was high in both survey types, but exceptionally high among the catches by commercial fishermen. Confidence limits on the estimated kill derived from the on-board survey were unacceptably wide (some ±82% of the estimates), and the upper limits on the estimate overlapped the lower limits on the estimates from simulated fishing by a very wide margin. Thus, it was not surprising to find that the CUE's were not significantly different in a statistical sense.

Apparently larger sample sizes, particularly from the on-board survey, were required. With such wide confidence limits and the discrepancy in estimates between the two survey types, our confidence in the estimated kill is not high. Presently, we can only speculate that the true value lies somewhere between the two independent estimates, and it may be that our pooled estimate of some 7,000 bass would be the best approximation of the true kill (assuming 100% mortality). However, while we were able to narrow the commercial effort data down to grid areas encompassing only the study area, the area of water within each grid is large (Figure 3) and we do not know in certainty how much of this effort was distributed in the areas fronting the Fishing Reserve Boundary.

Our impression is that most fishermen in these waters fish as close to the line as possible. If this is not true and a substantial portion of the effort occurs in deeper waters well away from the line, then it is

possible that incidental catches in the deeper waters will be considerably different from those occurring near the line, thereby biasing our mortality estimates, probably upwards (expansions to commercial effort include all effort in each grid regardless of fishing locations within the grids). Furthermore, commercial fishermen may, from past experience, purposely avoid areas on the line which tend to yield high incidental catches of bass. Clearly, more detailed information concerning the distribution of effort within these grids is required to increase our confidence in the estimates. Thus, while no statistically significant difference in smallmouth bass CUE's was detected between the two survey types, the apparent wide discrepancy bears further examination in future investigations.

The estimates of incidental bass mortality in this report include only one short period of time, that being from late July through August for both years. Selection of this time period arose from discussions with anglers and observations by OMNR conservation officers. These individuals argue that incidental kills are most severe in late July and August when bass leave their spawning grounds in the Inner Bay to seek the cooler waters of the outer bay. Shifts in the distribution of angler success from the Inner Bay to deeper outer bay waters are a common observation in OMNR creel surveys (MacGregor and Witzel 1986) and support the contention of such late summer emigrations. It is during this emigration in late July and August that the vulnerability by bass to commercial gill net is thought by some to be highest. It is unlikely that incidental catches are zero on either side of this period; thus, our estimates should not be misconstrued as total annual kills - they represent only the five

week period in question. Information concerning incidental catches in other seasons is lacking; therefore, it is premature to speculate on the total annual kill.

Some contend that because good smallmouth bass angling has persisted in Long Point Bay for decades in spite of commercial gillnetting activities, then this issue is of little consequence because the bass population has experienced this incidental mortality each year. However, it should be pointed out that the level of gillnet effort in Long Point Bay has not been stable. On the contrary, annual gillnet effort in Statistical District 4 (which includes Long Point Bay and adjacent waters; Figure 3) has increased substantially in recent years (1972-1978 mean = 4,937 km; 1980-1983 mean = 8,135 km) (Cox 1982 and supplements, Baker et al. 1985, MacGregor and Witzel 1986). Even within the six grid locations in question, annual smallmesh gillnet effort has increased over the period in which fishermen have reported their fishing locations (1977-1979 mean = 3,601.2 km, 1980-1983 mean = 4,671.6 km). Thus, the levels of incidental bass mortality may have increased in recent years, and the validity of this argument is in doubt.

Clearly, further study of this issue is required before we can answer many questions pertaining to the severity of the incidental catch. An incidental kill of some 7,000 bass may not seem severe in the face of annual harvests by sport fishermen which average 50,000 or more bass per year (estimated catches in 1982 and 1983 approached 90,000 bass) (MacGregor and Witzel 1986). However, we have no estimate of the total, annual incidental kill, and confidence in existing estimates of

the mortality in late July and August is low. Additional work is required to examine the seasonal levels of incidental bass catches (thus enabling estimates of total, annual kills), and to more accurately determine the distribution of commercial effort within the grid locations in question. In addition, an assessment of the level of incidental bass catches in nets set further from the line is required before potential management options can be assessed and developed. Evaluating the biological impact of incidental kills may require estimating the smallmouth bass population size; presently, no population estimates for this species in Long Point Bay are available.

In the interim, cursory examinations of potential survival from entanglement suggest that it may be possible to reduce the mortality of bass substantially if commercial fishermen would routinely take the time to remove the bass from their nets at the puller and release them immediately. However, our examination of this possibility was crude and only provides some insight into short term survival. It is possible that some mortality will be delayed beyond the hour or so we examined fish in the holding tank; their survival subsequent to release in the natural environment cannot be predicted.

6.0 CONCLUSIONS

In conclusion, our estimates of incidental smallmouth bass mortality are at best preliminary, and no management action should be taken on this basis alone. Much more intense study of the problem is required to resolve the uncertainties described in this report and to substantially increase our ability to provide estimates in which we

are reasonably confident. If this issue continues to be of concern it is strongly recommended that funding be made available to study the levels of incidental smallmouth bass mortality in much more detail. Of particular importance are:

(1) further and more intense on-board observations of actual commercial fish catches,

(2) studies of incidental catches through all seasons in which commercial fishermen operate,

(3) surveys to determine the distribution of commercial effort within the grid locations in question,

(4) attempts to estimate the size of the smallmouth bass population, particularly in the Inner Bay, and

(5) examinations of trends in incidental catches as nets are set further from the Fishing Reserve Boundary.

Finally, evaluation of the incidental kill and its effect on the bass population should not be done without considering the substantial harvest of bass by anglers

Table 1. Summary of stretched mesh sizes and total net lengths (m) per strap used in simulated commercial fishing.

TIME PERIOD	STRAP NO.	TOTAL NO. OF NETS	TOTAL LENGTH OF NET (m)	STRETCH MESH SIZE		TOTAL LENGTH OF EACH MESH (m)
				in	mm	
July 25 - 27 1983	Strap 1	21	1413	2 1/8	53.8	73
				2 3/16	55.6	455
				2 1/4	57.2	660
				2 5/16	58.7	24
				2 3/8	60.2	201
	Strap 2	22	1270	2 1/8	53.8	0
				2 3/16	55.6	249
				2 1/4	57.2	746
				2 5/16	58.7	60
				2 3/8	60.2	215
August 1983 August 1984	Strap 1	20	1350	2 1/8	53.8	73
				2 3/16	55.6	459
				2 1/4	57.2	665
				2 5/16	58.7	24
				2 3/8	60.2	129
	Strap 2	20	1174	2 1/8	53.8	0
				2 3/16	55.6	155
				2 1/4	57.2	754
				2 5/16	58.7	62
				2 3/8	60.2	203

NOTE: In 1984 all nets less than 57-mm (2-1/4 in) mesh were replaced with this mesh size.

Table 2. Sampling schedule, gillnet effort, catches and CUE's (No/km, kg/km) of yellow perch and smallmouth bass taken by 1983 simulated commercial fishing, Long Point Bay, Lake Erie.

		EFFORT	SMALLMOUTH BASS				YELLOW PERCH			
Lift Date	Location	# Meters	Total No.	Total Wt. kg	No/km	kg/km	Total No.	Total Wt. kg	No/km	kg/km
Jul. 26	12	1413	22	3.59	15.57	2.54	224	19.69	158.53	13.93
Jul. 26	42	1270	31	5.88	24.41	4.63	158	19.57	124.41	15.41
Jul. 27	25	1413	8	1.04	5.66	0.74	244	21.96	172.68	15.54
Jul. 27	22	1270	23	3.75	18.11	2.95	40	3.40	31.50	2.68
Aug. 3	35	1350	0	0.00	0.00	0.00	176	16.52	130.37	12.24
Aug. 3	41	1174	16	2.66	13.63	2.27	127	16.81	108.18	14.32
Aug. 4	48	1350	0	0.00	0.00	0.00	112	12.31	82.96	9.12
Aug. 4	14	1174	3	0.42	2.56	0.36	145	14.07	123.51	11.98
Aug. 9	3	1350	23	2.53	17.04	1.87	96	8.32	71.11	6.16
Aug. 9	46	1174	4	0.58	3.41	0.49	149	16.21	126.92	13.81
Aug. 10	7	1350	21	2.43	15.56	1.80	257	24.49	190.37	18.14
Aug. 10	19	1174	14	1.96	11.93	1.67	196	20.44	166.95	17.41
Aug. 16	34	1350	36	6.47	26.67	4.79	522	49.50	386.67	36.67
Aug. 16	44	1174	27	5.34	23.00	4.55	75	9.85	63.88	8.39
Aug. 17	11	1350	14	2.28	10.37	1.69	188	17.34	139.26	12.84
Aug. 17	16	1174	14	2.16	11.93	1.84	71	7.44	60.48	6.34
Aug. 23	32	1350	6	1.04	4.44	0.77	182	17.71	134.81	13.12
Aug. 23	20	1174	22	4.26	18.74	3.63	165	17.84	140.55	15.20
Aug. 24	28	1350	12	1.96	8.89	1.45	460	42.16	340.74	31.23
Aug. 24	17	1174	21	2.86	17.89	2.44	135	12.54	114.99	10.68
POOLED LOCATIONS		25,558	317	51.21	12.40	2.00	3722	368.17	145.63	14.41
MEAN		1278	16	2.56	12.49	2.02	186	18.41	143.44	14.26

Table 3. Sampling schedule, gillnet effort, catches and CUE's (No/km, kg/km) of yellow perch and smallmouth bass taken by 1984 simulated commercial fishing, Long Point Bay, Lake Erie.

			EFFORT	SMALLMOUTH BASS				YELLOW PERCH			
Lift Date	Location	Strap No.	No. Meters	Total No.	Total Wt. kg	No/km	kg/km	Total No.	Total Wt. kg	No/km	kg/km
Jul. 24	57	1	1350	2	0.49	1.48	0.36	220	24.30	162.96	18.00
Jul. 24	16	2	1174	22	2.97	18.74	2.53	137	15.61	116.70	13.30
Jul. 25	29	1	1350	6	0.84	4.44	0.62	80	8.21	59.26	6.08
Jul. 25	35	2	1174	1	0.37	0.85	0.31	80	9.30	68.14	7.92
Jul. 26	48	1	1350	0	0.00	0.00	0.00	76	7.76	56.30	5.75
Jul. 26	58	2	1174	1	0.12	0.85	0.10	98	10.90	83.48	9.28
Jul. 31	59	1	1350	51	8.06	37.78	5.97	174	17.90	128.89	13.26
Jul. 31	19	2	1174	22	2.73	18.74	2.33	653	68.30	556.22	58.18
Aug. 1	63	1	1350	3	0.41	2.22	0.30	239	24.94	177.04	18.47
Aug. 1	4	2	1174	3	0.42	2.56	0.36	39	4.36	33.22	3.71
Aug. 2	10	1	1350	5	0.65	3.70	0.48	199	19.88	147.41	14.72
Aug. 2	27	2	1174	30	4.65	25.55	3.96	173	18.47	147.36	15.73
Aug. 8	52	1	1350	3	0.49	2.22	0.36	293	29.63	217.04	21.95
Aug. 8	50	2	1174	0	0.00	0.00	0.00	109	11.05	92.85	9.41
Aug. 9	24	1	1350	8	1.02	5.93	0.75	277	26.35	205.19	19.52
Aug. 9	17	2	1174	3	0.52	2.56	0.44	102	10.14	86.88	8.63
Aug. 10	49	1	1350	20	2.90	14.82	2.14	162	16.29	120.00	12.07
Aug. 10	30	2	1174	2	0.28	1.70	0.24	134	12.84	114.14	10.94
Aug. 14	44	1	1350	1	0.17	0.74	0.13	505	47.25	374.07	35.00
Aug. 14	55	2	1174	88	10.55	74.96	8.99	114	12.33	97.10	10.50
Aug. 15	60	1	1350	44	4.93	32.59	3.65	112	12.45	82.96	9.22
Aug. 15	15	2	1174	21	2.09	17.89	1.78	59	6.06	50.26	5.16
Aug. 16	7	1	1350	3	0.33	2.22	0.24	26	2.39	19.26	1.77
Aug. 16	3	2	1174	11	1.15	9.37	0.98	89	8.78	75.81	7.47
Aug. 21	37	1	1350	27	4.42	20.00	3.27	237	23.23	175.56	17.21
Aug. 21	20	2	1174	20	2.75	17.04	2.34	265	26.90	225.72	22.91
Aug. 22	23	1	1350	45	6.10	33.33	4.52	148	14.87	109.63	11.02
Aug. 22	14	2	1174	39	4.89	33.22	4.16	54	5.73	46.00	4.88
Aug. 28	12	1	1350	16	3.66	11.85	2.71	28	3.30	20.74	2.44
Aug. 28	65	2	1174	3	0.82	2.56	0.69	135	15.59	114.99	13.28
Aug. 29	9	1	1350	19	2.74	14.07	2.03	28	2.47	20.74	1.83
Aug. 29	26	2	1174	11	2.08	9.37	1.77	159	15.43	135.43	13.14
POOLED LOCATIONS			40,384	530	73.60	13.12	1.82	5204	533.01	128.86	13.20
MEAN			1262	17	2.30	13.23	1.83	163	16.66	128.79	13.21

Table 4. Sampling schedule, gillnet effort, catches and CUE's (No/km, kg/km) of yellow perch and smallmouth bass observed in actual catches by commercial gillnet fishermen, Long Point Bay, Lake Erie (1984).

FISHERMAN NUMBER	LIFT DATE	GRID LOC.	EFFORT (METERS)	SMALLMOUTH BASS				YELLOW PERCH			
				Total No.	Total Wt. kg	C U E		Total[1] No.	Total Wt. kg	C U E	
						No/km	kg/km			No/km	kg/km
1	Jul. 26	110	3338	10	1.4	3.0	0.4	943	95.2	282.5	28.5
2	Jul. 28	94	2743	22	3.1	8.0	1.1	305	30.8	111.2	11.2
3	Aug. 1	95	3658	88	11.8	24.1	3.2	225	22.7	61.5	6.2
4	Aug. 2	111	8230	1	0.1	0.1	0.1	898	90.7	109.1	11.0
5	Aug. 9	110	3018	2	0.3	0.7	0.1	337	34.0	111.7	11.3
6	Aug. 10	137	3658	1	0.2	0.3	0.1	90	9.1	24.6	2.5
7	Aug. 22	110	2560	89	13.2	34.8	5.2	314	31.7	122.6	12.4
7	Aug. 22	138	2560	20	3.0	7.8	1.2	584	59.0	228.1	23.0
8	Aug. 23	138	6437	30	5.2	4.7	0.8	629	63.5	97.7	9.9
9	Aug. 24	112	9144	55	6.7	6.0	0.7	898	90.7	98.2	9.9
10	Aug. 28	94	3840	13	1.6	3.4	0.4	135	13.6	35.2	3.5
11	Aug. 31	110	3795	7	0.9	1.8	0.2	449	45.4	116.9	11.8
POOLED LOCATIONS			52,981	338	47.5	6.4	0.9	5807	586.4	109.6	11.1
MEAN			4,415	28	4.0	7.9	1.1	484	48.9	116.6	11.8

[1] Number of yellow perch estimated from landed weight (average weight = 101 g).

Table 5. Numbers of fish captured per kilometer of gill net in 1983 simulated commercial fishing, Long Point Bay, Lake Erie.

Location	CUE (fish/km)				
	Smallmouth Bass	Yellow Perch	Gizzard Shad	Target Non-Target	All Fish
3	17	71	129	274	345
7	16	190	127	397	587
11	10	139	1140	1263	1402
12	16	159	272	515	673
14	3	124	64	215	338
16	12	60	380	485	545
17	18	115	3074	3285	3400
19	12	167	518	678	845
20	19	141	3595	3740	3881
22	18	31	68	139	170
25	6	173	51	311	484
28	9	341	1778	1841	2182
32	4	135	1519	1644	1779
34	27	387	560	801	1188
35	0	130	26	420	550
41	14	108	2456	2921	3029
42	24	124	2611	2836	2961
44	23	64	1291	1779	1843
46	3	127	193	2003	2129
48	0	83	870	1398	1481
Pooled Locations	12	146	1087	1312	1458
Mean	13	144	1036	1347	1491

Table 6. Numbers of fish captured per kilometer of gill net in 1984 simulated commercial fishing, Long Point Bay, Lake Erie.

Location	CUE (fish/km) Smallmouth Bass	Yellow Perch	Gizzard Shad	Target Non-Target	All Fish
3	9	76	<1	83	159
4	3	33	0	55	88
7	2	19	<1	24	44
9	14	21	13	175	196
10	4	147	0	76	224
12	12	21	12	109	130
14	33	46	20	176	222
15	18	50	<1	136	187
16	19	117	0	75	192
17	3	87	0	73	160
19	19	556	0	219	775
20	17	226	31	247	473
23	33	110	33	266	376
24	6	205	0	70	276
26	9	135	90	417	552
27	26	147	0	39	187
29	4	59	0	25	84
30	2	114	3	55	170
35	<1	68	0	43	111
37	20	175	11	90	266
44	<1	374	38	246	620
48	0	56	0	19	76
49	15	120	4	69	189
50	0	93	2	79	172
52	2	217	1	279	496
55	75	97	23	311	408
57	1	163	1	164	327
58	<1	83	14	147	230
59	38	129	1	241	370
60	33	83	13	181	264
63	2	177	7	385	562
65	3	115	20	101	216
Pooled Locations	15	129	10	145	276
Mean	13	129	11	146	275

Table 7. Proportion of entangled smallmouth bass alive (A) at puller and (B) after entire strap was on board and picked, 1984 simulated commercial fishing, Long Point Bay, Lake Erie.

A.

DATE	LOCATION	NO. BASS ENTANGLED	ASSESSED AT PULLER NO. ALIVE	ASSESSED AT PULLER % ALIVE
Sept. 28	22	1	1	100.0
Sept. 26	13	1	1	100.0
Sept. 20	62	0	-	-
Sept. 19	42	0	-	-
Sept. 13	41	0	-	-
Sept. 12	8	37	35	94.6
Sept. 6	40	2	1	50.0
Sept. 5	32	14	12	85.7
Aug. 29	26	11	0	0.0
Aug. 28	65	3	1	33.3
POOLED		69	51	73.9
Aug. 22	23	45	36	80.0
Aug. 22	14	39	26	66.7
Aug. 21	20	20	17	85.0
Aug. 21	37	27	15	55.6
Aug. 16	3	11	9	81.8
Aug. 16	7	3	1	33.0
Aug. 15	60	44	25	56.8
Aug. 15	15	21	17	81.0
Aug. 14	44	1	1	100.0
Aug. 14	55	88	58	65.9
Aug. 10	30	2	2	100.0
Aug. 10	49	20	4	20.0
Aug. 9	17	3	2	66.7
Aug. 9	24	8	5	62.5
Aug. 8	52	3	1	33.3
Aug. 8	50	0	-	-
Aug. 2	27	30	22	73.3
Aug. 2	10	5	5	100.0
Aug. 1	63	3	1	33.3
Aug. 1	4	3	2	66.7
July 31	19	22	21	95.4
July 31	59	51	35	68.6
July 26	58	1	1	100.0
July 26	48	0	-	-
July 25	29	6	6	100.0
July 25	35	1	1	100.0
July 24	57	2	2	100.0
July 24	16	22	20	90.9
POOLED (Sept. 28-July 24)		550	386	70.2

B.

LOCATION	NO. BASS ENTANGLED	ASSESSED AFTER STRAP ON BOARD AND PICKED NO. ALIVE	ASSESSED AFTER STRAP ON BOARD AND PICKED % ALIVE
54	0	-	-
5	4	1	25.0
6	16	3	18.8
28	1	0	0.0
18	158	10	6.3
1	76	30	39.5
21	7	2	28.6
56	36	10	27.8
9	19	0	0.0
12	16	1	6.3
POOLED	333	57	17.1

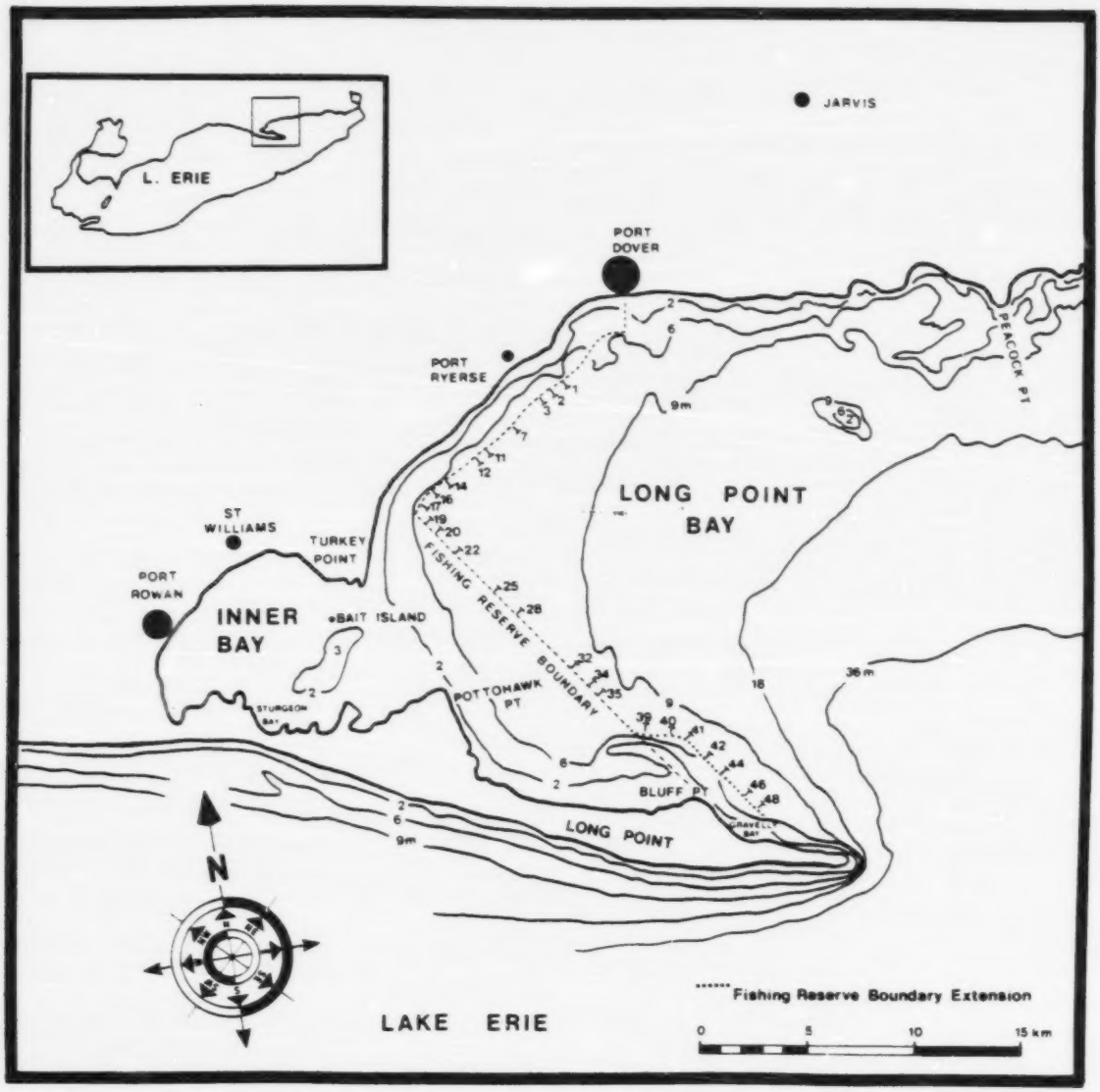


Figure 1. Sampling locations for 1983 simulated commercial fishing, Long Point Bay, Lake Erie.

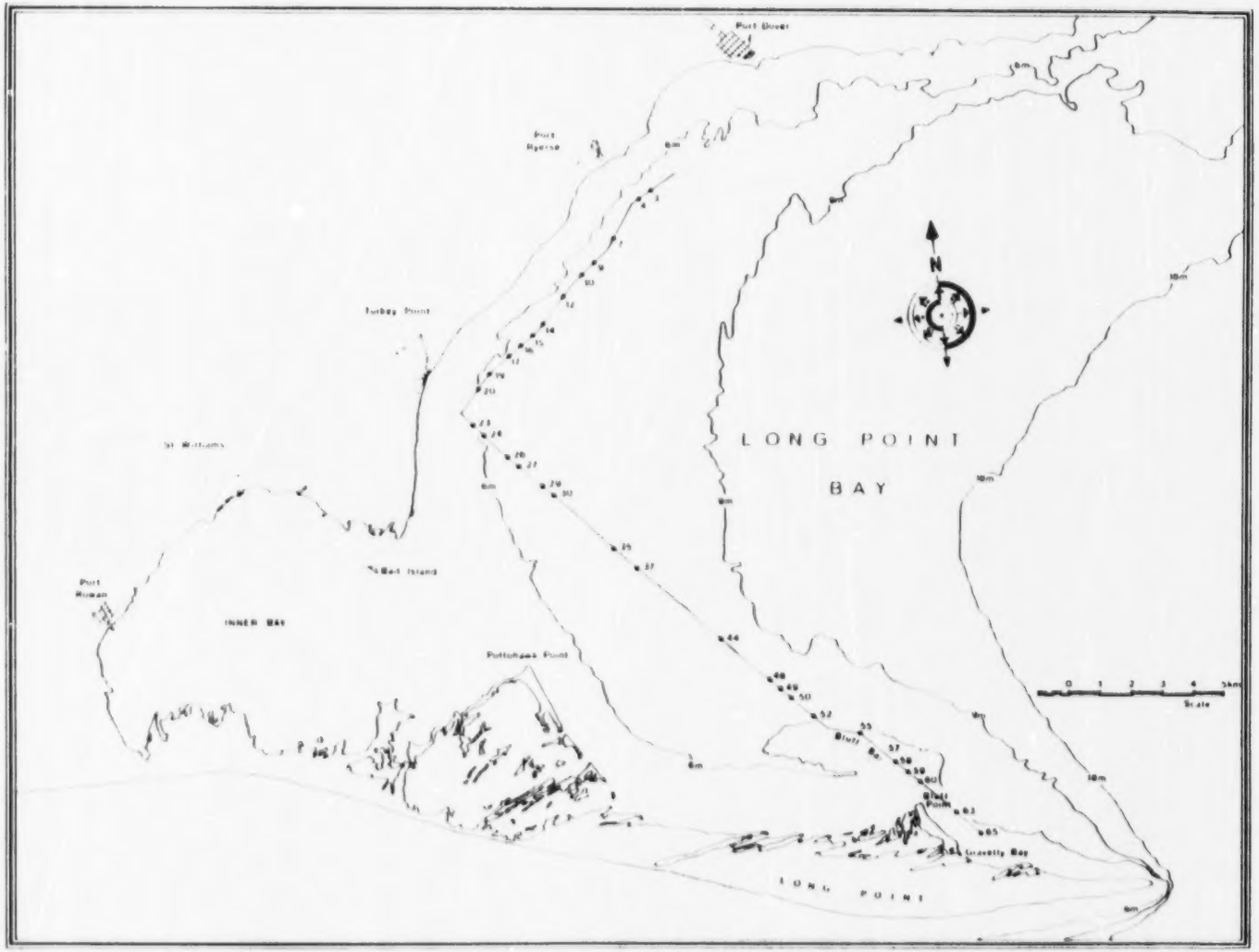


Figure 2. Sampling locations for 1984 simulated commercial fishing, Long Point Bay, Lake Erie.

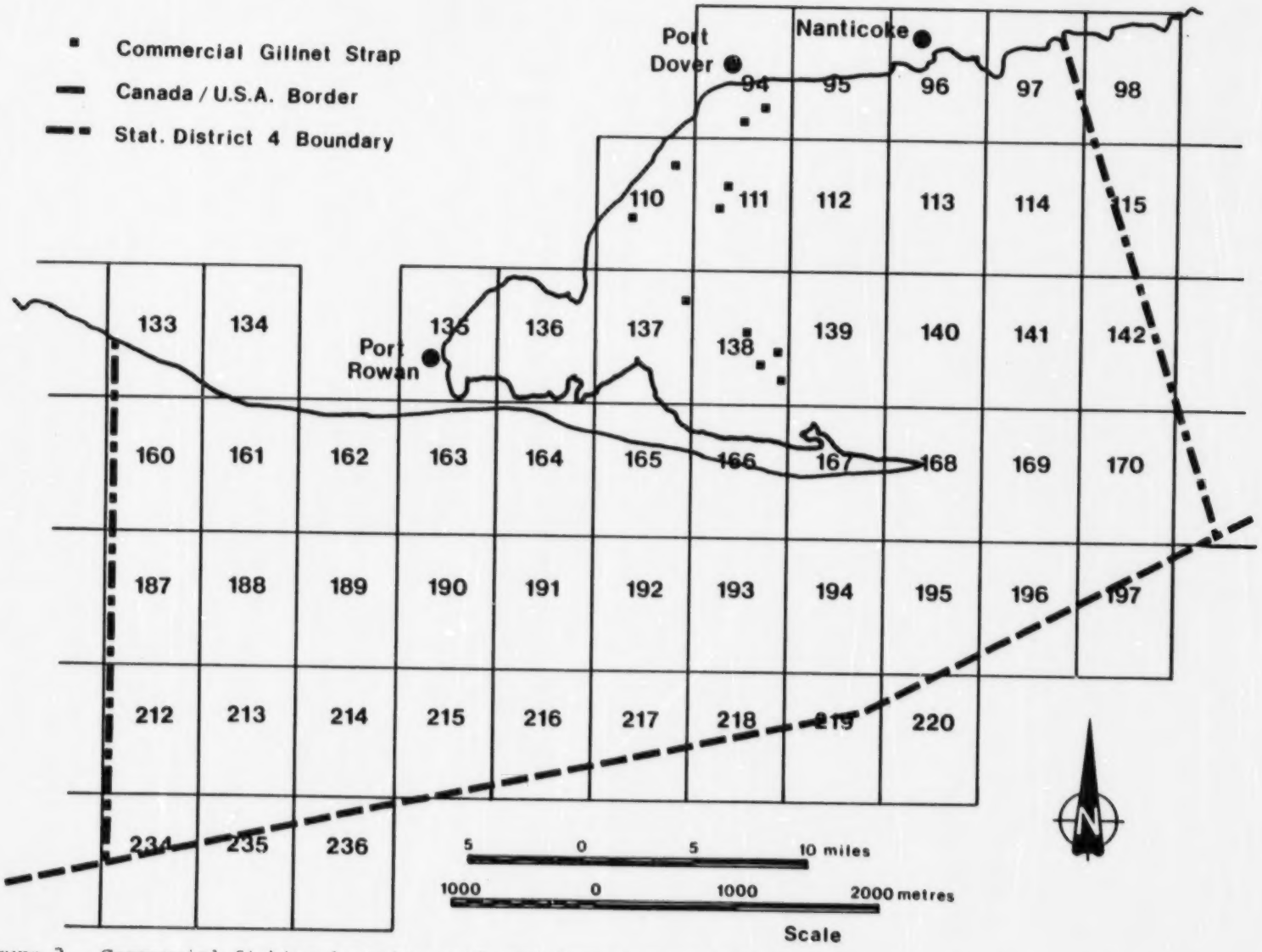


Figure 3. Commercial fishing location grids and locations of individual commercial gillnet straps examined during 1984 on-board surveys (Note: only those straps for which Loran-C coordinates were available are included on this map).

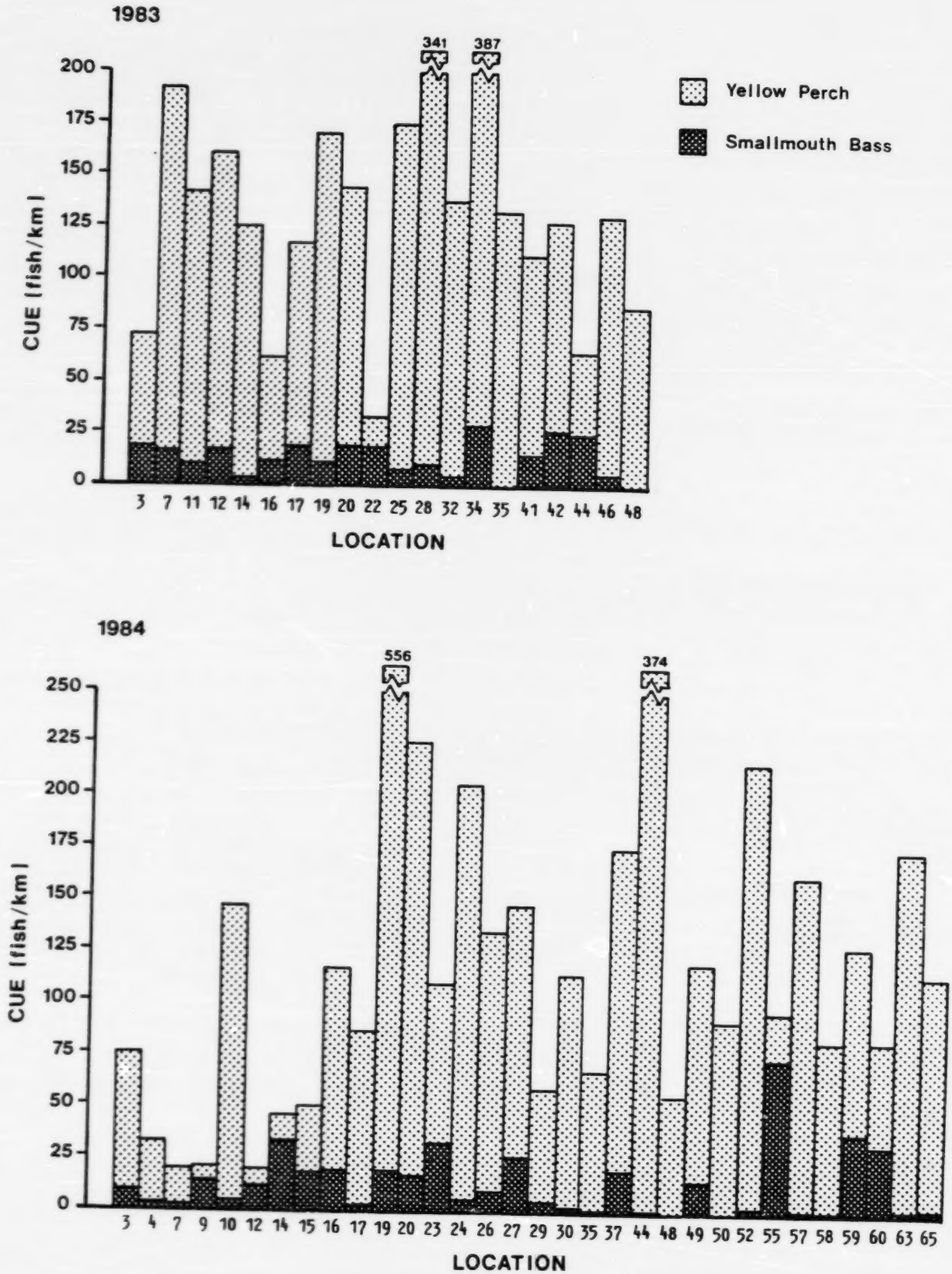


Figure 4. Catches per unit of gillnet effort (fish/km) of yellow perch and smallmouth bass from simulated commercial fishing in 1983 and 1984, Long Point Bay, Lake Erie.

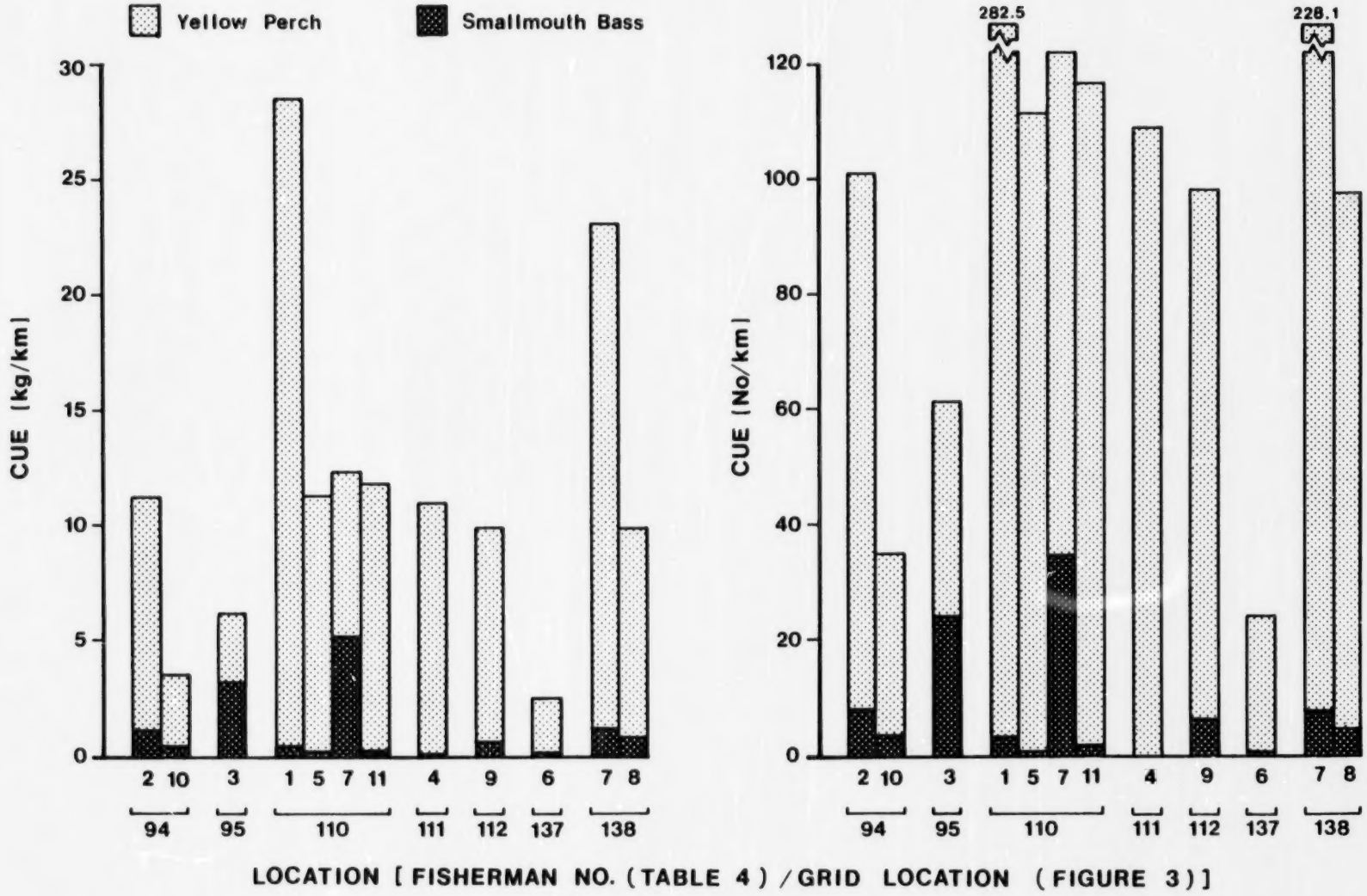


Figure 5. Catches per unit of gillnet effort (kg/km, fish/km) of yellow perch and smallmouth bass observed in commercial fish catches during the 1984 on-board survey, Long Point Bay, Lake Erie.

Appendix Table I. Sample calculation of estimated smallmouth bass kills by commercial gill net.

A. Late July-August Kills Estimated From Simulated Commercial Fishing Catches in 1983

1. Mean catch per lift of smallmouth bass in simulated commercial fishing = 15.85 (Std. Dev'n = 10.22; Std. Error = 2.28).
2. Average gillnet effort per set in simulated fishing = 1.281 km.
3. Total reported commercial effort expended within grids encompassing Fishing Reserve Boundary (July 24 - August 31, 1983) = 758.586 km.
4. No. equivalent units of simulated effort expended by commercial fishermen
   = 758.586 ÷ 1.281
   = 592.183
5. Estimated smallmouth bass kill between July 24 and August 31, 1983
   = 15.85 x 592.183
   = 9386 bass (assuming 100% mortality).
6. Standard Error of smallmouth bass kill
   = 2.28 x 592.183
   = 1350.18
7. 95% Confidence Limits on estimated kill
   = (Std. Error of estimated kill) x ($t_{.05}$, n - 1 = 19)
   = 1350.18 x 2.093
   = 2825.92
8. Estimated smallmouth bass kill between July 24 and August 31, 1983
   = 9386 ± 2826 bass

B. Late July-August Kills Estimated From Actual Commercial Fishing Catches During 1984 On-Board Survey

1. Mean catch per fishing occassion of smallmouth bass by commercial fishermen = 30.73 (Std. Dev'n = 37.38; Std. Error = 11.27, N = 11).
2. Total number of reported smallmesh gillnet fishing occassions between July 24 and August 31, 1983 = 203.
3. Estimated smallmouth bass kill = 203 x 30.73
   = 6238.19
4. Std. Error of estimated kill = 203 x 11.27
   = 2287.81
5. Confidence limits on estimated kill
   = (Std. Error of estimated kill) x ($t_{.05}$, n - 1 = 10)
   = 2287.81 x 2.228
   = 5097.24
6. Estimated smallmouth bass kill = 6238 ± 5097 bass.

C. Pooled Estimated Smallmouth Bass Kill (Combining 1984 Simulated Fishing Data With 1984 On-Board Survey Data)

1. Ratio estimate of Snedecor and Cochran (1980):

   where: $\hat{R}$ = pooled smallmouth bass CUE

   $$= \frac{\Sigma \text{ catches}}{\Sigma \text{ effort}} = \frac{868 \text{ bass}}{93.365 \text{ km}} = 9.297 \text{ bass/km}$$

2. Total reported commercial effort expended within grids encompassing Fishing Resere Boundary = 758.586 km.

3. Estimated smallmouth bass kill = 9.297 x 758.586
   = 7052.57

4. Std. Error of estimated kill $s(\hat{Y}_R) = N \sqrt{\frac{\Sigma(y_i - \hat{R}x_i)^2}{n(n-1)}} \cdot \sqrt{1 - \emptyset}$

   where: N = number of reported fishing occassions between July 24 and August 31
   = 203

   n = number of samples = 32(simulations) + 11(on-board)
   = 43

   $\emptyset$ = sampling fraction = $\frac{n}{N} = \frac{43}{203}$

   y_i = smallmouth bass catch from i^{th} samples

   x_i = effort expended in i^{th} sample

   $s(\hat{Y}_R) = 203 \sqrt{(30460.05)/43(42)} \cdot \sqrt{1 - (43/203)}$
   $= 203(4.107)(0.8878)$
   $= 740.15$

5. 95% confidence limits on pooled estimated kill (assume Z)
   = 740.15 x 1.96
   = 1450.69

6. Pooled estimated smallmouth bass kill = 7053 ± 1451 bass.

NOTE: For late July-August kills using 1984 simulated commercial fishing, follow same procedure as part A using the following data:
mean catch/lift = 16.56 (std. error = 3.47)
average gillnet effort/set = 1.262 km

APPENDIX Figure I

ATTENTION ANGLERS!

INNER BAY FISH SANCTUARY

A Fish Sanctuary has been established by Regulation on part of Inner Long Point Bay. It is now necessary to refrain from all fishing between May 15 to the last Saturday in June each year — in the area labelled NO FISHING AREA below.

The Sanctuary is to protect the bass fishery during the spawning period.

The number of anglers fishing in Inner Long Point Bay during late May and June is increasing — resulting in increased stress on the bass.

Even an accidentally hooked (and returned) bass guarding its nest can mean the loss of its reproduction effort for the year . . . and that means fewer bass in the years to come.

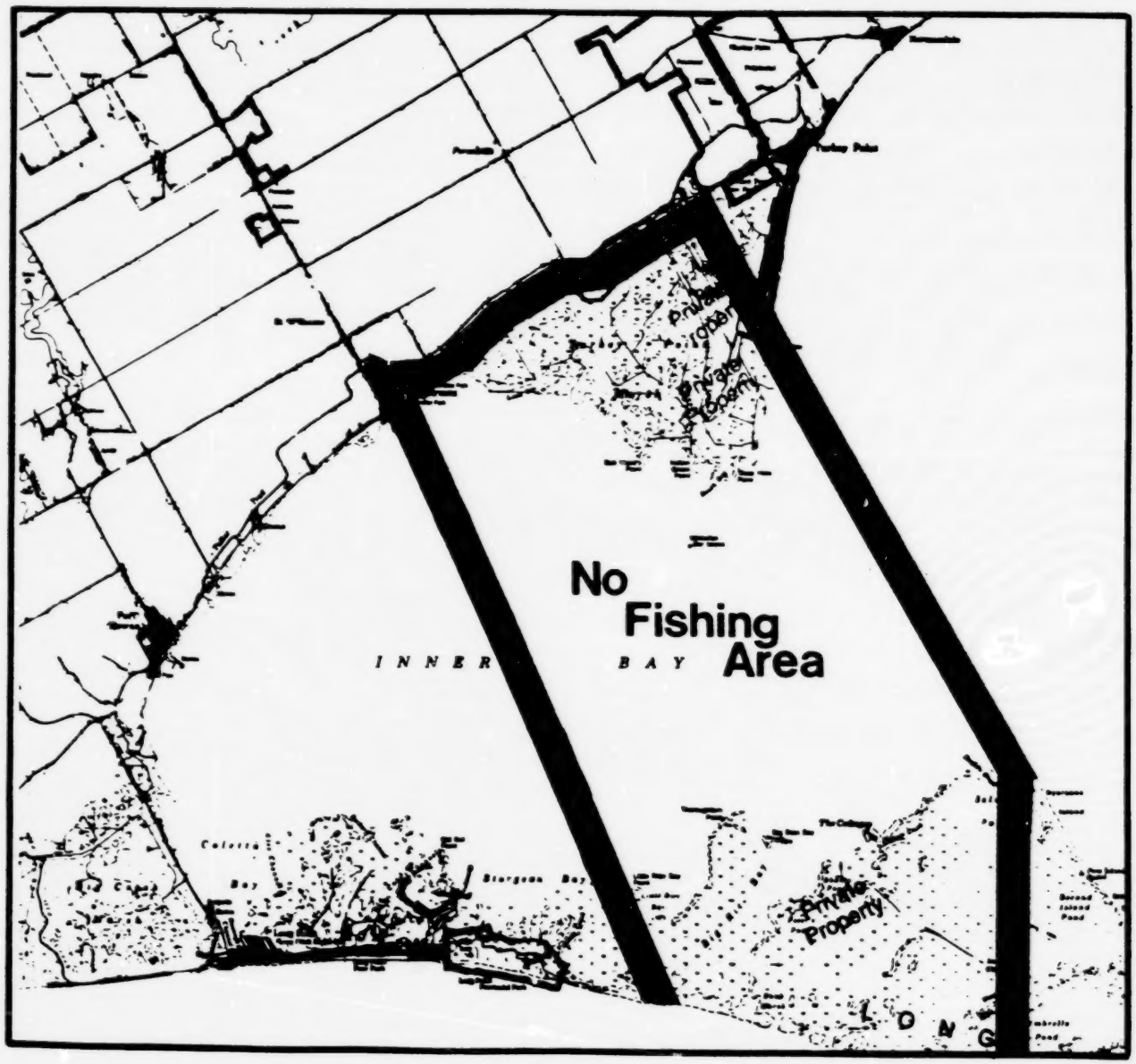
Your cooperation will help the bass — and protect your sport!

Ontario

Ministry of Natural Resources

Hon. Vincent G. Kerrio
Minister

Mary Mogford
Deputy Minister



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